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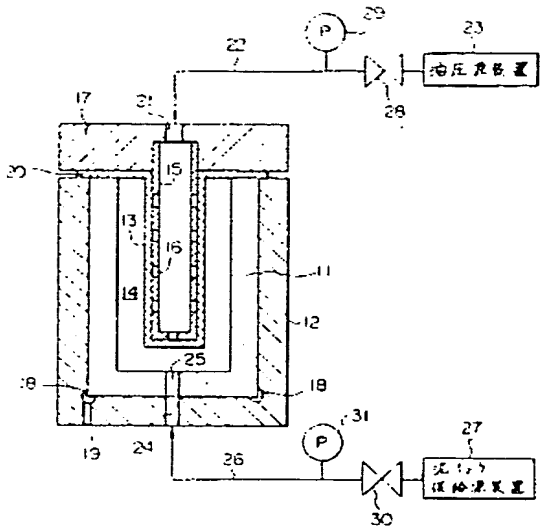
TITLE : METHOD AND APPARATUS FOR CAST-COMPACTING SLURRY



ABSTRACT : PURPOSE: To easily manufacture a green compact for sintering having uniform quality and high density by making fine ceramic and metal powders slurry state with water, forcibly feeding pressure oil into a rubber mold after pouring the slurry into a porous mold having the rubber mold in inner part thereof, expanding and removing moisture in the slurry with this pressure.

CONSTITUTION: Outside of the mold 11 composed of porous material is supported with firm outer frame 12 and the rubber mold 13 is set in the inner part thereof, and the flange part 20 thereof is firmly held on the upper faces of mold 11 and outer frame 12 with a pressing plate 17. Guide tube 15 having plural through holes 16 is set in the rubber mold 13. The slurry composed of fine ceramic, metal powders and water is forcibly fed into space 14 at intermediate gap between the mold 11 and the rubber mold 13 from a supplying device 27 through communicating holes 24, 25 arranged at bottom parts of the mold 11 and the outer frame 12, and a large part of moisture in the slurry is discharged from hole in the mold 11. Successively, the pressure oil is pressed into the rubber mold 13 from a hydraulic device 23 through the guide tube 15 and residual moisture in the slurry is extruded with expansion of the rubber mold and the green compact having hollow part in the inner part is formed, and by sintering this, the high quality powder metallurgical product is manufactured.

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METHOD AND DEVICE FOR SLURRY CASTING MOLDING

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[There are no amendments to this patent.]

Claims

1. A slurry casting molding method characterized by the following facts: according to the slurry casting molding method, a feed material of a sintered product of fine ceramics or metals is processed into a slurry, and, after the slurry is cast in a mold, water content of the slurry is removed to form a molding; in this slurry casting molding method, said mold is made of a porous material that allows permeation of water; also, an elastically deformable hollow rubber die is set inside said mold; after said slurry is cast between said mold and rubber die, the interior of the rubber die is pressurized to inflate the rubber die, so that water content in the slurry is removed through said mold.

2. A slurry casting molding device characterized by the fact that the slurry casting molding device is for forming from a slurry of feed powder a molding of a sintered product of fine ceramics or metals, and it has a mold made of a porous material that allows permeation of water content in the slurry, an elastically deformable hollow rubber die set inside said mold, and a pressurizing device that feeds a pressurizing fluid into the rubber die to inflate it.

3. The slurry casting molding device described in Claim 2 characterized by the following facts: on the inner side of said rubber die, a guide tube for holding the rubber die is set; through holes for passing of said pressurizing fluid are formed on the guide tube; and said pressurizing fluid is fed under pressure into said guide tube.

Detailed explanation of the invention

Industrial application field

This invention pertains to a technology for manufacturing sintered products of fine ceramics and metals. In particular, this invention pertains to a method for molding feed powder before sintering.

Prior art

When sintered products of fine ceramics and metals are manufactured, before sintering, the feed powder is molded into the shape of the product. In the prior art, a slurry casting molding method has been adopted to mold the feed powder. In this method, the feed powder is mixed with water to form a slurry and the slurry is cast in a mold, followed by removal of water content from the slurry to form the molding. In this case, removal of water content from the slurry is

usually carried out under the self-pressure of the slurry. However, when a plate-shape molding is to be formed, as shown in Figure 2, a filter press method is adopted. In this method, a compressive force is applied by ram (6) on the slurry (5) filled in mold (4) composed of die (1) and punches (2), (3), so that water is exhausted through plural holes (7)... formed on punch (2).

Problems to be solved by the invention

In the conventional slurry casting molding method in which water content is removed under the self-pressure of the slurry, it is hard to obtain a homogeneous high-density molding. Consequently, there is a significant drying shrinkage of the molding, so that cracks are formed in drying. Also, when sintered products of fine ceramics are manufactured, since a high sintering temperature is needed, it is hard to form a fine sintered structure, and it is impossible to realize high strength and toughness for the finally obtained sintered products. This is undesired.

Although this problem is alleviated a little with the filter press method shown in Figure 2, the filter press method nevertheless can be used only in forming plate-shape moldings. This is a problem.

Also, in the conventional method, it is hard to remove a core, so that it is hard to form a hollow molding. When a hollow molding is formed, the density distribution in the thickness direction is uneven, so that it is prone to generation of cracks in sintering. This is undesired.

The objective of this invention is to solve the aforementioned problems of conventional methods by providing a slurry casting molding method that can effectively form a homogeneous and high-density molding or a hollow molding, as well as a device that can be used preferably in embodiment of said method.

Means to solve the problems

This invention provides a slurry casting molding method characterized by the following facts: according to the slurry casting molding method, a feed material of a sintered product of fine ceramics or metals is processed into a slurry, and, after the slurry is cast in a mold, water content of the slurry is removed to form a molding; in this slurry casting molding method, said mold is made of a porous material that allows permeation of water; also, an elastically deformable hollow rubber die is set inside said mold; after said slurry is cast between said mold and rubber die, the interior of the rubber die is pressurized to inflate the rubber die, so that water content in the slurry is removed through said mold.

Also, this invention provides a slurry casting molding device characterized by the fact that the slurry casting molding device is for forming, from a slurry of feed powder, a molding of sintered product of fine ceramics or metals, and it has a mold made of a porous material that allows permeation of water content in the slurry, an elastically deformable hollow rubber die set

inside said mold, and a pressurizing device that feeds a pressurizing fluid into the rubber die to inflate it. In this case, the following scheme is preferred: on the inner side of said rubber die, a guide tube for holding the rubber die is set; through holes for passing of said pressurizing fluid are formed on the guide tube; and said pressurizing fluid is fed under pressure into said guide tube.

Operation

According to the method of this invention, the interior of the rubber die is pressurized so that the rubber die is elastically deformed and inflated. Since the rubber die applies hydrostatic pressure from the inner side on the slurry, water content in the slurry is exhausted through the mold. As a result, the slurry is subject to filtering compaction.

Also, for the device of this invention, the pressurizing fluid is fed under pressure from a pressurizing device into the rubber die to inflate the rubber die. Consequently, the slurry is pressed from the inner side, and water content in the slurry is exhausted through the mold made of a porous material. When application of pressure on the rubber die is stopped, the rubber die shrinks under its own elasticity.

Application example

In the following, this invention will be explained in detail with reference to an application example illustrated by a figure.

Figure 1 is an overall schematic cross-sectional view illustrating the device for forming a hollow molding in a bottomed cylindrical shape, that is, in a cup shape. In the figure, (11) represents a mold; (12) represents an outer frame for holding said mold (11) from the outer side; and (13) represents a rubber die set at the center within said mold (11). Casting space (14) for a casting slurry (not shown in the figure) is formed between the outer surface of said rubber die (13) and the inner surface of mold (11).

(15) represents a guide tube that is set inside rubber die (13) and has plural through holes (16)... formed on it. (17) represents a pressing plate that is fixed with respect to outer frame (12) and closes the opening portion of the upper portion of mold (11). The upper end portion of said guide tube (15) is fixed on the central portion of said press plate (17).

Said mold (11) is made of a porous material that allows permeation of water content from the slurry. Water that has passed said mold (11) is exhausted through water exhausting groove (18) and exhausting hole (19) formed on the bottom of outer frame (12).

Also, said rubber die (13) has its lower end closed, and has flange portion (20) on its upper end portion. Said flange portion (20) is held between the upper surface of outer frame (12) and press plate (17). Also, it is held within mold (11) by means of guide tube (15) set inside it.

Through hole (21) is formed on said press plate (17) and it is connected to said guide tube (15). A pressurizing oil (pressurizing fluid) is fed under pressure from hydraulic source device (23) (pressuring device) through said through hole (21) and hydraulic pipe (22) into guide tube (15). When the pressurizing fluid is fed under pressure into guide tube (15), the hydraulic pressure acts via through holes (16)... formed on guide tube (15) on the inner surface of rubber die (13). As a result, rubber die (13) is elastically inflated.

Also, at the center on the bottoms of outer frame (12) and mold (11), through holes (24) and (25) are formed, respectively, and they are connected to each other. Slurry is fed under pressure from slurry feeding device (27) through said through holes (24), (25) and slurry feeding pipe (26) into casting space (14).

Valve (28) and pressure gauge (29) are mounted mid-way on said hydraulic pipe (22). In addition, valve (30) and pressure gauge (31) are mounted mid-way on slurry feeding pipe (26).

When molding is performed using the device with the aforementioned constitution, first of all, valve (28) is closed, while valve (30) is opened. A prescribed amount of slurry is fed under a prescribed pressure through slurry feeding pipe (26) into casting space (14). Since rubber die (13) is held on the inner side by guide tube (15), rubber die (13) is not broken under pressure of the slurry.

After casting space (14) is filled with slurry, water content in the slurry is suctioned into mold (11). When the pores of mold (11) are full of water, water flows from mold (11) into outer frame (12), and it is exhausted through water exhausting groove (18) and water exhausting hole (19). The amount of exhausted water depends on the concentration of the slurry and the casting pressure. It decreases with time. Soon, water exhausting from mold (11) stops, and the slurry forms a cake.

In this way, preparatory molding comes to an end. Then, formal molding takes place.

Valve (30) is closed, while valve (28) is opened, and pressurizing fluid is fed from hydraulic source device (23) into guide tube (15), and its pressure is increased gradually. Then, the pressure is maintained on a preset level as pressure gauge (29) is monitored.

As a result, the entirety of rubber die (13) is inflated uniformly, and the premolded cake is pressed from the inner side. Consequently, hydrostatic pressure is applied on the premolded from the inner side for filtering compaction. As a result, water content left in the premolded is exhausted through mold (11), and a high-density molding is obtained.

After the completion of molding, the hydraulic source device (23) is turned off, and feed of hydraulic pressure is stopped. As a result, rubber die (13) shrinks to recover its original shape under its own elasticity. Then, press plate (17) is opened, and rubber die (13) is removed together with guide tube (15) from mold (11). After that, the molding is removed from mold (11).

When molding is performed according to the aforementioned process and using the aforementioned device, the obtained molding has higher density and better uniformity in the thickness direction than one prepared using a conventional method. Consequently, for such molding, the drying shrinkage is small, and cracks can hardly from in drying. Also, the shape maintaining strength of the molding is high, so that the molding can be released from mold (11) easily. In addition, since the obtained molding has high density and good homogeneity, when fine ceramic sintered products are manufactured, the sintering temperature can be set lower. As a result, one can obtain sintered products with fine structure.

In addition, by shrink rubber die (13), rubber die (13) can be released easily from the molding. In a conventional method that uses a core, performance of molding is difficult. Now, using the method of this invention, a hollow molding can be formed easily.

In the aforementioned application example, hydraulic source device (23) is used as a pressurizing device for inflating rubber die (13). However, any other appropriate pressurizing device may also be used, as long as hydraulic pressure is used. Also, in the aforementioned application example, a bottomed cylindrical molding is formed. However, by changing the shape of the mold and rubber die, one can also form simple cylindrical or other hollow shaped moldings.

Effect of the invention

As explained in detail above, according to the method of this invention, by applying pressure inside a rubber die to inflate it, hydraulic pressure is applied on the slurry from the inner side. Consequently, water content in the slurry can be removed through said mold. As a result, it is possible to form a molding with high density, good homogeneity of density in the thickness direction, small drying shrinkage, high shape maintainence strength, and ease of mold release. Consequently, a sintered product with a fine structure can be obtained. Also, it is possible to form a hollow molding easily, which has been hard to do in the prior art. These are excellent effects of this invention.

Also, the device of this invention has a mold made of a porous material that allows permeation of water content from the slurry, an elastically deformable hollow rubber die set inside said mold, and a pressurizing device for feeding a pressurizing fluid under pressure into the rubber die to inflate it. Consequently, by means of the pressurizing device, the rubber die can be inflated easily, and, when pressurizing is stopped, the rubber die shrinks, so that mold release can be performed easily. Consequently, this device can be used preferably in embodiment of the aforementioned method. Since a guide tube is set on the inner side of the rubber die, and through holes for passing of the pressurizing fluid are formed on the guide tube, it is possible to prevent the rubber die from breaking under the pressure of the slurry. This is an advantage.

Brief description of the figures

Figure 1 is a cross-sectional view illustrating the slurry casting molding device in an application example of this invention.

Figure 2 is a cross-sectional view illustrating an example of a conventional slurry casting molding device.

11	Mold
12	Outer frame
13	Rubber die
14	Casting space
15	Guide tube
16	Through hole
17	Press plate
18	Water exhausting groove
19	Water exhausting hole
20	Flange portion
21	Through hole
22	Hydraulic pipe
23	Hydraulic source device (pressurizing device)
24, 25	Through hole
26	Slurry feeding pipe
27	Slurry feeding source device
28, 30	Valve
29, 31	Pressure gauge

//insert p. 5//

Figure 1

Key: 23 Hydraulic source device
27 Slurry feeding source device

Figure 2